

19 May 1969

Matériel Test Procedure 4-4-006
U. S. Army Arctic Test Center

U. S. ARMY TEST AND EVALUATION COMMAND
ENVIRONMENTAL TEST PROCEDURE

ARCTIC ENVIRONMENTAL TEST OF RECOILLESS AMMUNITION

AD 718608

1. OBJECTIVE

The objective of this procedure as outlined in this MTP is to provide a means of evaluating the performance of recoilless ammunition under arctic winter environmental conditions.

2. BACKGROUND

Engineering tests of recoilless ammunition are conducted to determine the characteristics and performance of the ammunition under various conditions of operation, and to ensure their compliance with specified requirements. Testing in a natural arctic winter environment is used to substantiate or supplement data obtained from simulated tests conducted during the Engineer Design and Engineering Test phase. Testing in arctic winter environment generally is not authorized until data from simulated environmental tests provides reasonable assurance that the test item will function satisfactorily when subjected to the conditions that would be encountered in the arctic.

3. REQUIRED EQUIPMENT

- a. Weapons as required
- b. Comparison ammunition as required
- c. Standard American targets
- d. Support aircraft
- e. Drop zones
- f. Rigging area
- g. Appropriate measuring equipment (linear & weight)
- h. Meteorological measuring equipment
- i. Vehicles as required
- j. Firing range and targets
- k. General and special maintenance tools, kits and ancillary items as specified in technical manuals
- l. Cameras and film

4. REFERENCES

- A. AR 705-15 chg. 1, Operations of Materiel Under Extreme Conditions of Environment
- B. AR 705-5, Army Research and Development
- C. AR 70-10, Army Materiel Testing
- D. AR 70-8, Human Factors and Social Sciences Research
- E. AR 750-6, Maintenance Support Planning
- F. USATECOM Reg 705-2, Documenting Test Plans and Reports
- G. MTP 4-2-509, Air Drop Capability of Explosive Material

5. SCOPE

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5.1 SUMMARY

The procedures outlined in this MTP are designed to determine and evaluate the functioning characteristics of recoilless ammunition under arctic winter environment conditions.

The specific subtests to be performed and their intended objectives are listed below:

a. Preoperational Inspection and Physical Characteristics - This test provides for an inspection of the test item to:

- 1) Identify damage received during shipping and handling
- 2) Determine its physical condition
- 3) Determine if the test item weight, dimensions, and characteristics conform to applicable criteria.
- 4) Locate any defects

b. Firing - The objective of this test is to determine the accuracy of recoilless ammunition when fired from the appropriate support weapons under arctic winter conditions.

c. Velocity - The objective of this test is to determine the velocity of the recoilless ammunition at the muzzle of the support weapons when fired under arctic winter conditions.

d. Position Disclosing Effect - The objective of this test is to determine the position disclosing effect created by the smoke, muzzle flash and ice fog when firing ammunition under arctic winter conditions.

e. Functional and Operational Suitability - Portability - The objective of this test is to determine the ease of carrying and transporting the test ammunition cross-country and over ski trails while wearing snowshoes and skis.

f. Aerial Delivery - The objective of this test is to determine the suitability of the test ammunition for Phase I airborne operations under arctic environmental conditions.

g. Human Factors Engineering - The objective of this test is to determine if the test ammunition is compatible with the skills, aptitudes, and limitations of the using personnel under arctic winter conditions.

h. Maintenance Evaluation - The objective of this test is to determine if the test ammunition meets maintenance and maintainability requirements as defined by QMR, SDR, TC, MC or other established criteria under arctic winter environment.

5.2 LIMITATIONS

The procedures described in this MTP are limited to the testing of recoilless ammunition under arctic winter environmental conditions. Specific tests for other ammunition may be performed using this MTP as a guide with the variations applicable to the ammunition to be tested.

6. PROCEDURES

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6.1 PREPARATION FOR TEST

a. Arctic winter environmental tests are normally scheduled from October through March (6 months). Tests, test comparison and support weapons should be delivered to the Arctic Test Center prior to 1 October.

b. TDY Personnel will be used to augment assigned personnel and will be trained to the degree that they are as proficient on the individual weapons as the troops who will use the weapon.

c. Ensure that all test personnel are familiar with the required technical and operational characteristics of the item under test, such as stipulated in Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), and Technical Characteristics (TC), and record this criteria in the test plan.

d. Review all instructional material issued with the test item by the manufacturer, contractor, or government, as well as reports of previous tests conducted on the same types of equipment, and familiarize all test personnel with the contents of such documents. These documents shall be kept readily available for reference.

e. Record the grade, MOS, background, and training of all test personnel and ensure that all personnel receive new equipment training (NET) as required.

f. Record the following information:

- 1) Nomenclature, serial number(s), and manufacturer's name of the test items.
- 2) Nomenclature, serial number, accuracy tolerances, calibration requirements, and last date calibrated of the test equipment selected for the tests.

g. Select test equipment having an accuracy ideally 10 times greater than that of the function to be measured.

h. Prepare record forms for systematic entry of data, chronology of test, and analysis in final evaluation.

i. Prepare adequate safety precautions to provide safety for personnel and equipment, and ensure that all safety SOP's are observed throughout the test.

j. Ensure that when not in use, all test ammunition and control weapons in their appropriate containers are stored and maintained in an unsheltered area and exposed to ambient air temperature and prevailing weather conditons.

k. Record the prevailing meteorological conditions during the storage phase, as well as test conduct, to include:

- 1) Temperature
- 2) Humidity, relative or absolute
- 3) Temperature gradient
- 4) Atmospheric pressure
- 5) Precipitation
- 6) Solar radiation
- 7) Wind speed and direction
- 8) Frequency of readings
- 9) Source of data

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1. Record the length of time a test item was stored prior to conduction of each test and the temperatures to which the test item was exposed during storage.

6.2 TEST CONDUCT

NOTE: When conducting individual weapon test involving several subjects, samples and conditions i.e., range, temperature position, etc., a "Latin Square" or comparable test design procedure will be imposed to assure a representative distribution of variables and minimum biasing.

6.2.1 Preoperational Inspection and Physical Characteristics

a. Upon receipt, carefully inspect all test items and control weapons and their shipping and/or packaging containers for completeness, damage, and general conditions. Photograph any damage or deterioration noted.

NOTE: Technical manuscripts, manuals, or other publications supplied shall be used as guides for the inspection.

b. Record the following:

- 1) Inventory of all test items
- 2) Damage or deterioration noted

c. Measure and weigh each test item and comparison ammunition (or a representative number of them) and record the following:

- 1) Dimensions (length, width, height, etc.) and weight of the test item and comparison ammunition.
- 2) Identification photograph of test and comparison of ammunition.

6.2.2 Firing Tests

6.2.2.1 Accuracy firing

a. Cold-soak (outdoors for a period of at least 24 hours) all test and comparison ammunition, at prevailing ambient air temperature (from 0°F to the coldest available temperature).

b. Inspect all test and comparison ammunition for loose, damaged, or missing parts.

c. Install stationary targets at ranges indicated in the test plan and table I. Zero all weapons used for test and comparison firings at the appropriate range. Record any difficulties encountered.

NOTE: The targets shall be at least 2.3 x 2.3 meters square and shall be bounded by additional witness materiel (target cloth or plywood) in order to obtain miss distance data. The main target (2.3 x 2.3 meters) can be made of target

cloth, plywood, armor plate, concrete or other suitable material depending on the test objective. If armor penetration data is required the target must be of sufficient depth to contain the projectile. When accuracy data is required and inert warheads are used, the targets can be made of materials such as target cloth and plywood.

d. Each phase of the subtest shall be conducted in ambient air temperature of 0°F to -25°F, -25°F to -45°F and -45°F to the lowest available temperature.

e. Each gunner of ten gun crews shall fire the test and comparison from a fixed firing mount at targets located at ranges indicated in Table I.

TABLE I. ACCURACY FIRINGS - FIXED MOUNT

Type Target	Range to Target	Number of Rounds	
		Test	Control
Stationary	Min Range	10	10
Stationary	To be determined	10	10
Stationary	To be determined	10	10
Stationary	To be determined	10	10
Stationary	Max Range	10	10

f. The above exercises shall be repeated using trained gunners firing ten test rounds only (one per gunner) at realistic tank silhouette targets placed at ranges indicated in table II.

NOTE: The targets can be made of plywood or target cloth if inert warheads are used. If tank hulls are used only the frontal view of the tank hull will be visible. The targets shall be OD in color and not marked with an aiming point. The gunner shall not fire two consecutive rounds at the same range or observe other gunner firings.

g. Record the following data for each test:

- 1) Type of Ammunition
- 2) Ambient air temperatures
- 3) Target ranges
- 4) Number of rounds fired at each range.
- 5) Horizontal and Vertical Impact Coordinates
- 6) Center of Impact and Standard Deviation for each group of firings at each range.
- 7) Penetration data and photographs of target when applicable.

NOTE: This test and the following velocity firing test should be conducted concurrently.

TABLE II. SYSTEM ACCURACY - WITH TRAINED GUNNERS

Type Target	Range to Target	Number of Test Rounds
Stationary-Silhouette	Min Range	10
Stationary-Silhouette	To be determined	10
Stationary-Silhouette	To be determined	10
Stationary-Silhouette	To be determined	10
Stationary-Silhouette	Max Range	10

6.2.2.2 Velocity firing

a. Place two velocity coils on a line of sight with the selected targets used in the accuracy subtest (6.2.3.1). The coils shall be separated by ten feet with the first coil five feet from the muzzle of the weapon, as shown in figure 1.

b. Fire ten rounds of test ammunition through the coils using appropriate weapons.

c. Repeat step b, using ten rounds of comparison ammunition.

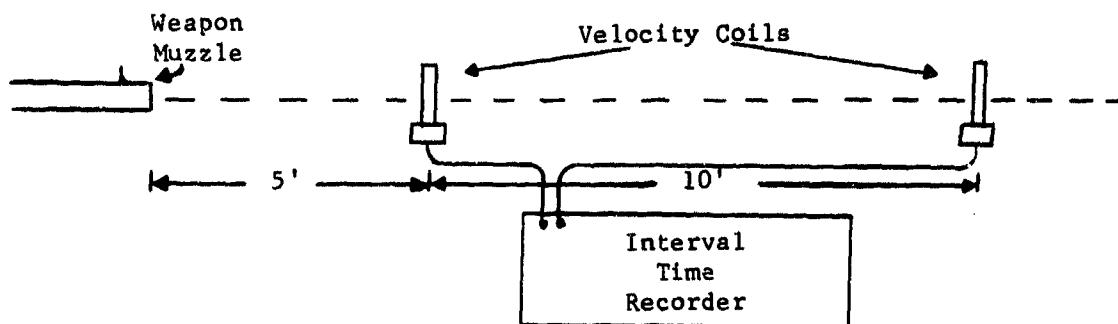


Figure 1

d. Record the following data:

- 1) Velocity readings of test ammunition
- 2) Velocity readings of comparison ammunition
- 3) Ambient air temperature at test site

6.2.3 Position Disclosing Effects

a. Cold-soak (outdoors for a period of at least 24 hours) all test and comparison ammunition at prevailing ambient air temperatures (0°F to the lowest available temperature).

b. Position an observer beside each gunner and down range at 100-meter intervals to the maximum range of the ammunition.

c. Mount cameras perpendicular to the muzzles of the weapons at sufficient distance to photograph all the flash and smoke but not closer than 4.5 feet.

d. Fire ten rounds each of test and comparison ammunition, under darkened conditions. Photograph the cumulative flash from each weapon.

e. Record the following data:

- 1) Smoke and flash effects at firing positions.
- 2) Smoke and flash effects visible to the observers at indicated range.
- 3) Annotations to the photograph of cumulative flash with regard to variations of flash during the firing.
- 4) Ambient air temperature at test site
- 5) Light conditions.

f. Repeat the above steps under daylight conditions without photographing the cumulative flash.

6.2.4 Functional and Operational Suitability - Portability

a. Cold-soak (outdoors for a period of at least 24 hours) all test and comparison ammunition, at prevailing ambient air temperatures (from 0°F to the coldest available temperature).

b. Inspect all ammunition for loose, damaged or missing parts, and place in the best possible serviceable condition. Six test crews with field gear and arctic uniforms shall carry and transport the test and comparison ammunition (packed in prescribed carrying case) over the following courses.

- 1) Snowshoe one mile through dense, snow-covered brush
- 2) Snowshoe one mile through open snow-covered (cross-country) terrain
- 3) Ski two miles over cross-country ski trails
- 4) Transport the ammunition 50 miles over tank trails and secondary roads in wheeled vehicles and 50 miles in tracked vehicles

c. Thoroughly inspect all ammunition and record the following:

- 1) Damage attributed to environmental effects
- 2) Problems encountered while transporting ammunition
- 3) Damage to ammunition due to transporting or handling
- 4) Ambient air temperatures during test
- 5) Actual mileage accumulation over each type of terrain and under specified condition

6.2.5 Aerial Delivery

a. Cold-soak (outdoors for a period of at least 24 hours) all test and comparison ammunition at prevailing ambient air temperatures (from 0°F to lowest available temperature).

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- b. Carefully inspect the test and comparison ammunition for damage.
- c. Subject the test and comparison ammunition to air drops in accordance with applicable procedures of MTP 4-2-509.
- d. Record the following data:
 - 1) Altitude and speed of delivery aircraft
 - 2) Ambient air temperature
 - 3) Results of inspections
 - 4) Malfunctions of test and comparison weapons
 - 5) Method used for attachment of ammunition to parachutists
 - 6) Compatibility with parachute equipment

6.2.6 Human Factors Engineering and Safety

- a. During the conduct of the entire test, ensure that all test personnel are outfitted with arctic equipment and "arctic winter clothing" consisting of:

- 1) Shirt, wool, OD 108
- 2) Trousers, field, OD 107, with liner
- 3) Undershirt, winter
- 4) Drawers, winter
- 5) Socks, wool, cushion sole
- 6) Boots, vapor barrier, white
- 7) Suspenders
- 8) Cap, pile
- 9) Parka, with liner and hood
- 10) Mitten set, arctic with liners

NOTE: The year round temperature variation peculiar to the arctic prohibits the prescribing of a particular uniform for any season. The clothing which is comfortable at -50°F becomes uncomfortable at -10°F and vice versa. Since this large fluctuation is experienced on a hour-to-hour, day-to-day basis, some degree of flexibility in uniform requirements is necessary. However, since materiel tested under arctic conditions is expected to function under the most adverse conditions, the uniform worn by operating personnel must also be suitable for the most adverse conditions. Accordingly the "arctic winter clothing" referred to in this MTP is defined above.

- b. Transport the test ammunition over cross-country terrain.
- c. Perform required maintenance and adjustments prior to firings.
- d. Fire test and comparison ammunition in corresponding weapons.

NOTE: Accomplish steps b through d concurrently with the preceding sub-tests.

e. Record the following:

- 1) Difficulties experienced in the operation, adjustment, maintenance, and transporting of the test and comparison ammunition.
- 2) Safety hazards encountered
- 3) Operator discomforts

6.2.7 Maintenance Evaluation

NOTE: Classification and definitions of malfunctions shall be as approved and commonly defined by all USATECOM testing agencies.

a. Throughout the conduct of all testing as outlined in this MTP, maintain a record of performance of all scheduled and unscheduled maintenance as prescribed in the appropriate draft publications.

NOTE: Whenever possible, maintenance shall be performed under prevailing arctic environmental conditions. Reasons why this is not possible shall be recorded.

b. Continuously monitor all maintenance operations for human factors, safety implications, and to determine if ease of maintenance has been included in the design of the equipment.

c. Compare all replacement parts and components provided with the test item with anticipated and actual requirements, evaluating spare parts requirements under arctic environmental conditions.

d. Record the following information:

- 1) Record of all scheduled and unscheduled maintenance performed to include lubrication, adjustments, repairs, and replacement of parts.
- 2) Favorable and unfavorable aspects of maintenance
- 3) Unsafe and inadequate aspects of maintenance operations
- 4) Mean time between failures (MTBF) and the mean time to repair (MTTR) the test ammunition and associated equipment
- 5) Repair parts usage
- 6) Suitability of cleaning equipment

e. Perform a reliability test of test and comparison ammunition by transporting the ammunition over tank trails and secondary roads in wheeled and tracked vehicles.

NOTE: Accomplish above steps concurrently with preceding subtests.

f. Record the following data:

- 1) Scheduled and unscheduled maintenance
- 2) Repair parts usage
- 3) Time between failures

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- 4) Operational time periods
- 5) Time to repair
- 6) Any malfunction, breakage or unusual occurrence as a result of durability tests
- 7) Comments on durability and reliability based on observations throughout the test

g. During performance of maintenance, utilize all common and special tools and test equipment furnished with the items under test, and record the following data:

- 1) Maintenance operations for which special tools are required
- 2) Common and special tools and test equipment required, but not furnished in the maintenance package
- 3) Tools and test equipment furnished but not required

h. Thoroughly analyze all publications provided with the test items for clarity and simplicity of maintenance instructions, and completeness of preventative maintenance procedures.

i. Monitor all maintenance operations to determine if instructions and the sequence of operations are adequate for the level of training possessed by appropriate maintenance personnel, or if added or special training is required.

j. Record the following data:

- 1) Accuracy and adequacy of maintenance publications
- 2) Requirements for special training and maintenance category requiring special training
- 3) Errors and/or omissions in nomenclature and parts numbers on repair parts lists.
- 4) Unclear and inadequate maintenance instructions
- 5) Inadequate safety instructions for personnel and equipment, including environmental protection during operation and maintenance.
- 6) Desirable changes and comments

6.3 TEST DATA

All test data to be recorded will be as specified in the individual sub-tests of this MTP.

6.4 DATA REDUCTION AND PRESENTATION

Processing of raw test data shall, in general, consist of organizing, marking for identification and correlation, and grouping the test data according to test title.

Specific instructions for the reduction and presentation of individual test data are outlined in succeeding paragraphs.

6.4.1 Preoperational Inspection and Physical Characteristics

Size and weight data, adequacy of packaging, and completeness of shipment data shall be compared with appropriate QMR's, SDR's, TC's, etc. Physical condition (damage) shall be compared with acceptable standards.

6.4.2 Firing Tests

Compare the mean radius, hit percentage, and cyclic rate of fire to weapon specifications for possible deviations due to arctic effects.

6.4.3 Velocity

Velocity data recorded from the test ammunition shall be compared with recorded velocity data from comparison ammunition and accepted military standards to determine the effect caused by exposure to arctic conditions.

6.4.4 Position Disclosing Effect

The data obtained from the test item shall be evaluated in accordance with data from comparison ammunition and accepted military standards.

6.4.5 Functional and Operational Suitability - Portability

The adequacy with which the weapon under tests feeds, extracts and ejects under extreme arctic winter conditions shall be determined by comparison with previously accepted items of like nature and specifications. The damage to the weapons attributed to environmental effects or handling shall be compared with weapon specifications contained in appropriate QMR and TC.

6.4.6 Aerial Delivery

The suitability of the test ammunition for Phase I airborne operations under arctic environmental conditions shall be determined in accordance with applicable procedures of MTP 4-2-509. The damage to the ammunition shall be compared with specifications in appropriate QMR or TC to evaluate the effects of the air drop on the test ammunition.

6.4.7 Human Factors Engineering and Safety

The data obtained and observations made during performance of this subtest shall be compared with accepted standards of human engineering.

6.4.8 Maintenance Evaluation

Time required for individual maintenance operations shall be examined to determine if the resulting downtime is considered excessive, based on experience with like-type items. The maintenance ratio shall be computed as outlined in Appendix A. Maintenance ratio (M) is the number of active maintenance man-hours (TM) required to support each hour of operation (TD). The maintenance ratio reflects the frequency of failures of the system and the amount of time required to locate, repair and replace faulty components or parts. It reflects the overall maintainability of the test weapon.

APPENDIX A

MAINTENANCE AND RELIABILITY ANALYSIS CHART

INSTRUCTION SHEET

DESCRIPTION

COLUMN

- 1 Group number as indicated in the Maintenance Allocation Chart.
- 2 Component and related operations as indicated in the Maintenance Allocation Chart. Operations indicated as in Depot Category are not shown.
- 3 Maintenance Level, Prescribed. Category prescribed by the Maintenance Allocation Chart is indicated by utilizing the letters O/C, O, DS, or GS. O/C - Operator of crew; O - Organizational; DS - Direct Support; GS - General Support.
- 4 Maintenance Level, Recommended. Letters O/C, O, DS, or GS indicated the category recommended by the test agency.
- 5 TM Instructions, Adequate. An X in this column indicates the TM instructions are considered adequate.
- 6 TM Instruction, Inadequate. The test agency reference number used on DA forms 1598 is indicated in this column, if the instructions are considered inadequate.
- 7 Active Maintenance Time. Man hours used to the closest tenth. If the operation was not actually performed but was received, the estimated active maintenance time is indicated by using the prefix E. Average active maintenance time is used if the operation was performed more than once.
- 8 Life. Number of hours, miles, or rounds accumulated before or since this operation was performed. An entry is made each time this operation is performed, followed by the appropriate life unit; i.e., M, H, or R. An "S" will be placed in this column if the operation was performed on a sampling basis and not because of an actual failure.
- 9 Reason performed. The symbol "Unsched" will be shown in this column if the operation was performed as a result of unscheduled maintenance. If the operation was performed as a result of scheduled maintenance, it is indicated by the symbol "Sched" in this column. If the operation was performed only to verify procedures and tools, not as a result of breakdown, it is indicated by the symbol "Sim" in this column.

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- 10 Remarks. If the operation is related to any other subtest covered in the body of the test report the paragraph number is inserted for cross reference. If the maintenance operation was not performed as a result of using the sampling technique authorized by AR 750-6, one of the following remarks is entered as appropriate.

- a. Reviewed - not performed.
- b. Neither reviewed nor performed due to (No TM's) or (insufficient service test time).
- c. Other, as appropriate.

If an EPR is related to a maintenance operation, the EPR number will be inserted.

A written report shall accompany all test data and shall consist of conclusions and recommendations drawn from test results. The test engineer's opinion, concerning the success or failure of any of the functions evaluated, shall be included. In addition, equipment specifications that will serve as the model for a comparison of the actual test results should be included.

Equipment evaluation will usually be limited to comparing the actual test results to the equipment specifications and the requirements as imposed by the intended usage. The results may also be compared to data gathered from previous tests of similar equipment.

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GROUP NO.	COMPONENT AND RELATED OPERATIONS	O/C - Oper/Crew				TM INSTRUCTIONS	ACTIVE MAINT TIME	LIFE M-Miles H-Hours R-Rounds	REASON PERFORMED	REMARKS
		0 - Orgzn	DA - Direct	GS - General						
1	2	3	4	5	6	Inadequate 1598	7	8	9	10

MAINTENANCE AND RELIABILITY ANALYSIS CHART